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8. LMSAL, 9. HAO, 10. IRSOL, 11. ASCR, 12. Univ. of Oslo



CLASP Launch Succeeded on Sep. 3rd, 2015



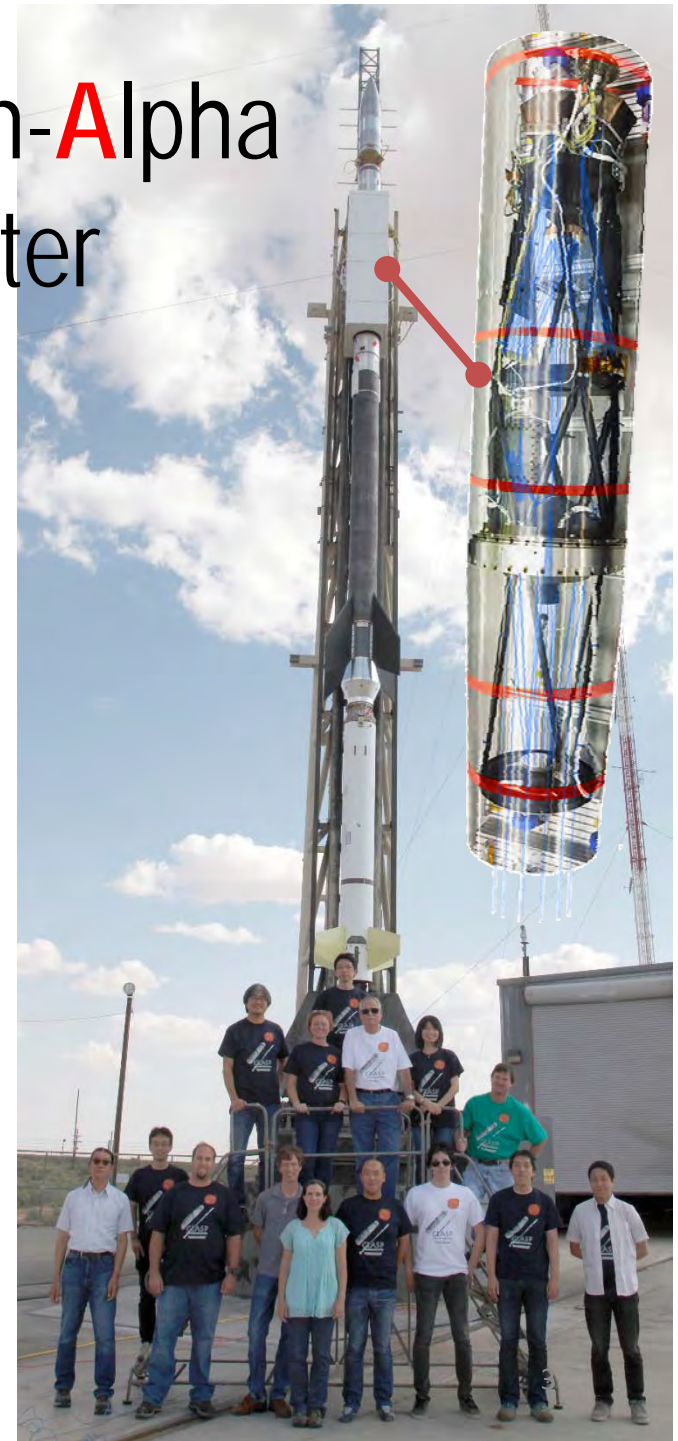


Chromospheric Lyman-Alpha Spectro-Polarimeter

- **High-precision** ($<0.1\%$) **spectro-polarimetry** in **VUV**.
- **First detection** of scattering polarization in the **Ly α line** (121.6 nm).
- **Exploration** of **magnetic fields** in **the upper chromosphere** and **the transition region** via the Hanle effect.

2015/09/17

Hinode 9

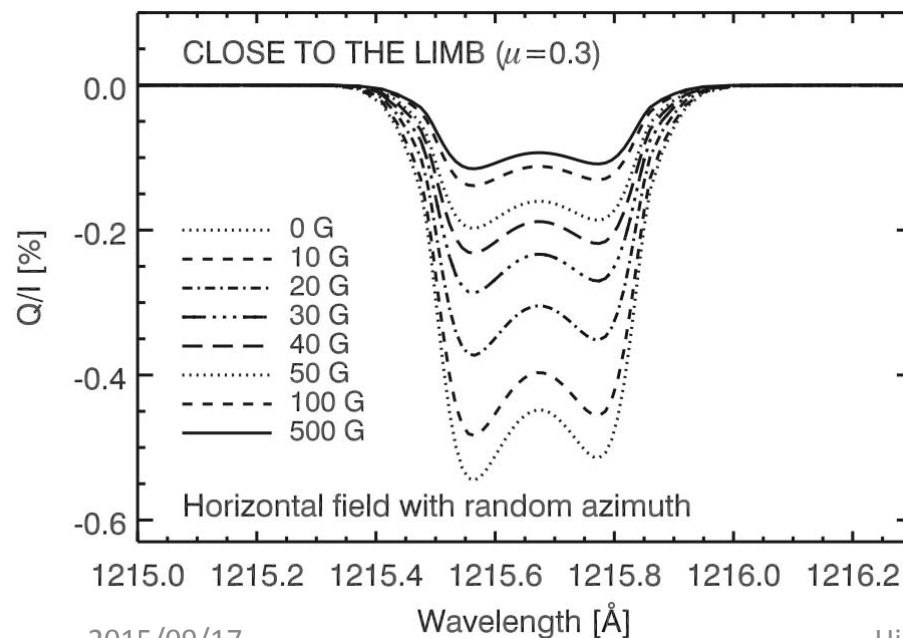




Hanle effect in Ly α line

Line core:

- atomic polarization + Hanle effect
- sensitive to 5 - 50 G



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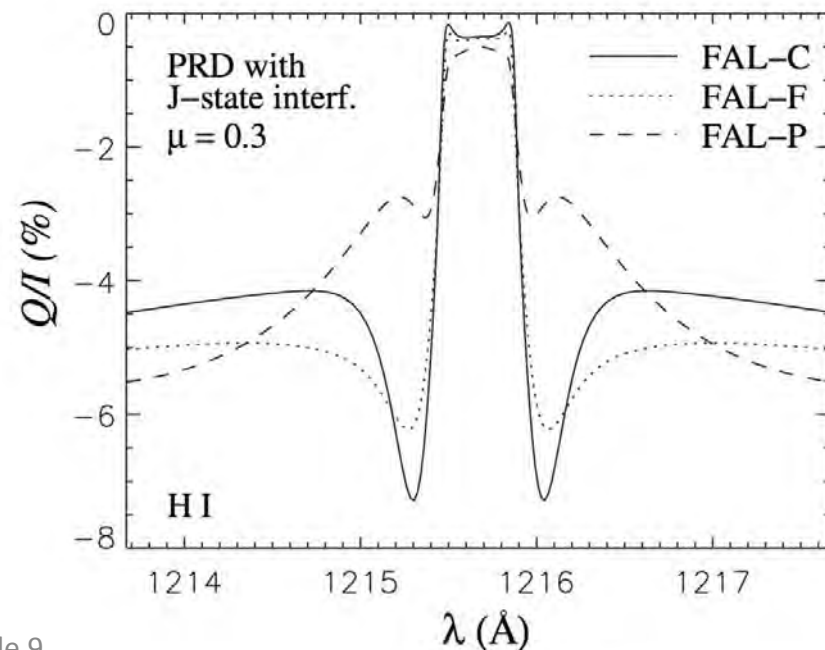
Wavelength [Å]

Hinode 9

Trujillo Bueno et al. (2011)

Line wing:

- atomic polarization ONLY
- sensitive to temperature structure

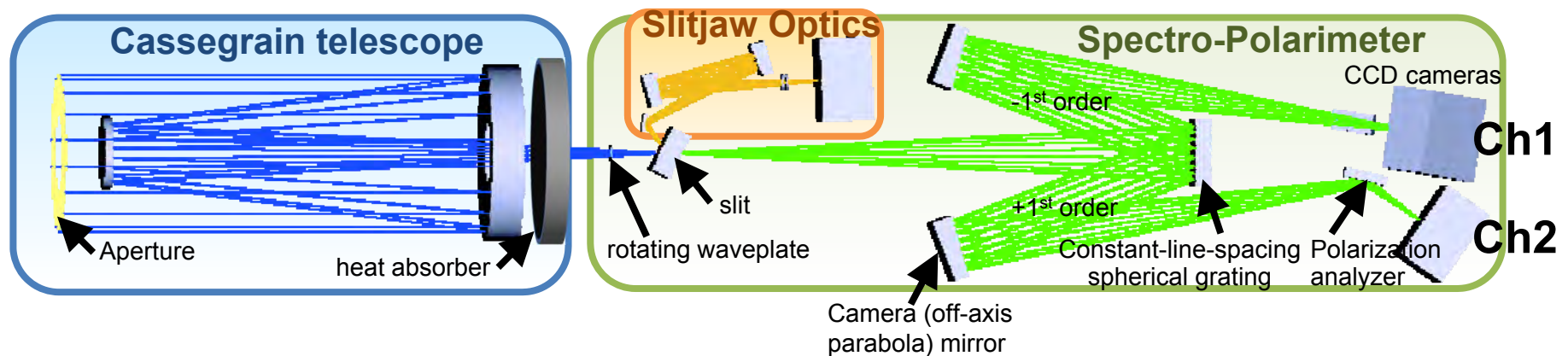


Belluzzi et al. (2012)



CLASP Instrument

Narukage et al. (2015, Applied Optics)

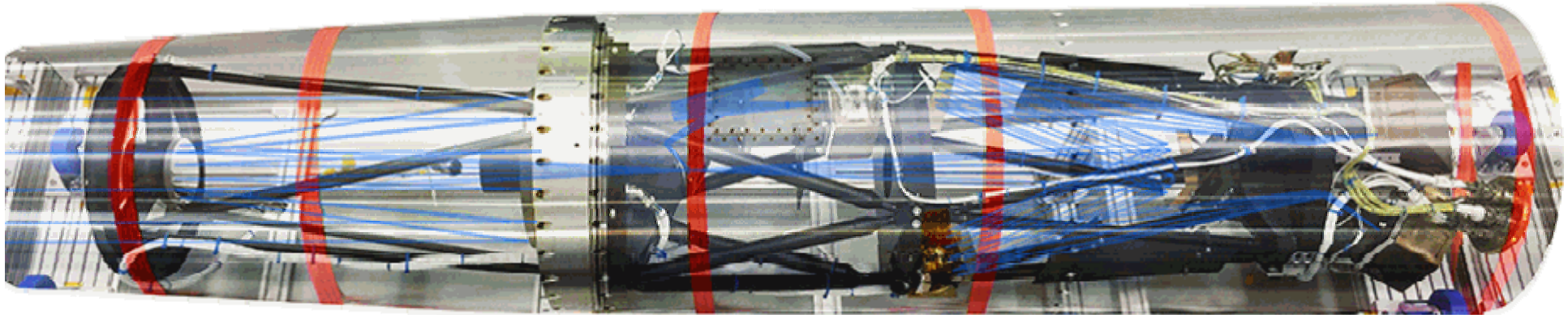


- Two symmetric channels: **Ch1 & Ch2**
 - ▶ Simultaneously measure **orthogonal polarization** states
- Realize high throughput in VUV
 - ◀ Minimize the number of optical components
 - ◀ Apply high-reflectivity coating to all optical components



CLASP Instrument

Narukage et al. (2015, Applied Optics)



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Observing procedure

Peak height was ~ 278 km.

[1] Initial ~ 10 sec

Disk center for the on-flight polarization calibration.

- SJ: >16 images with 0.6s cad.
- SP: >33 images with 0.3s cad.

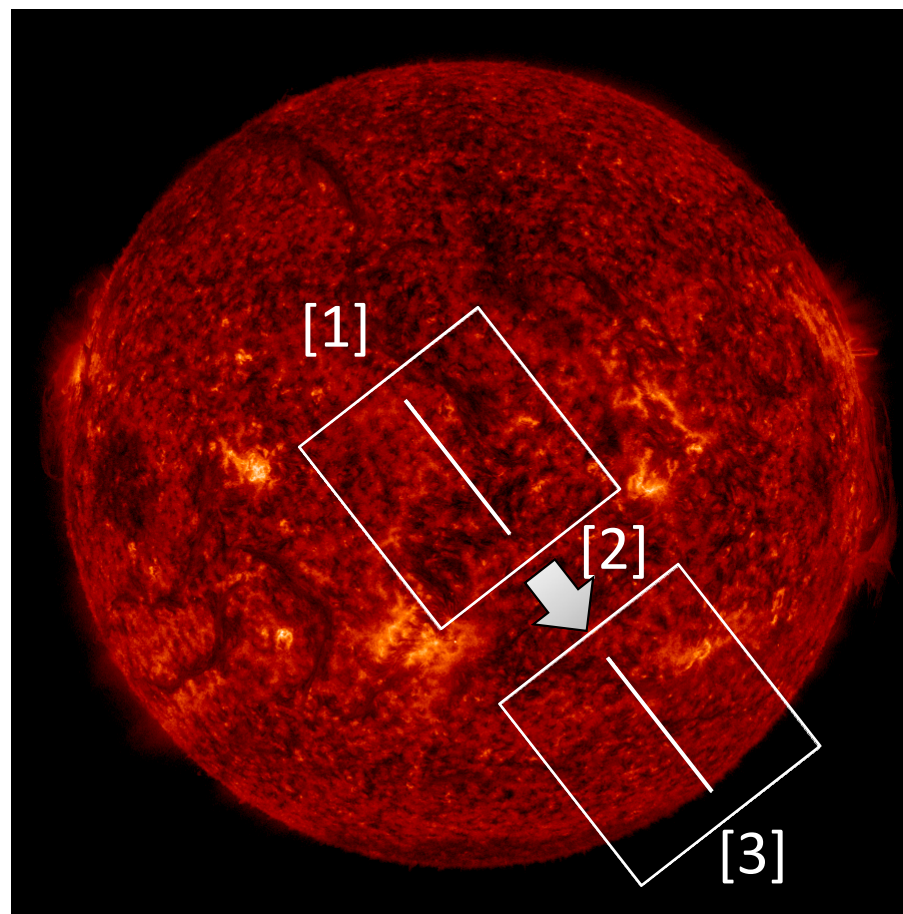
[2] ~ 30 sec for repointing.

[3] Remaining ~ 240 sec

Sit & stare in **QS** near SW limb.

Slit is **perpendicular to the limb**.

- SJ: > 466 images with 0.6 cad.
- SP: > 933 images with 0.3s cad.

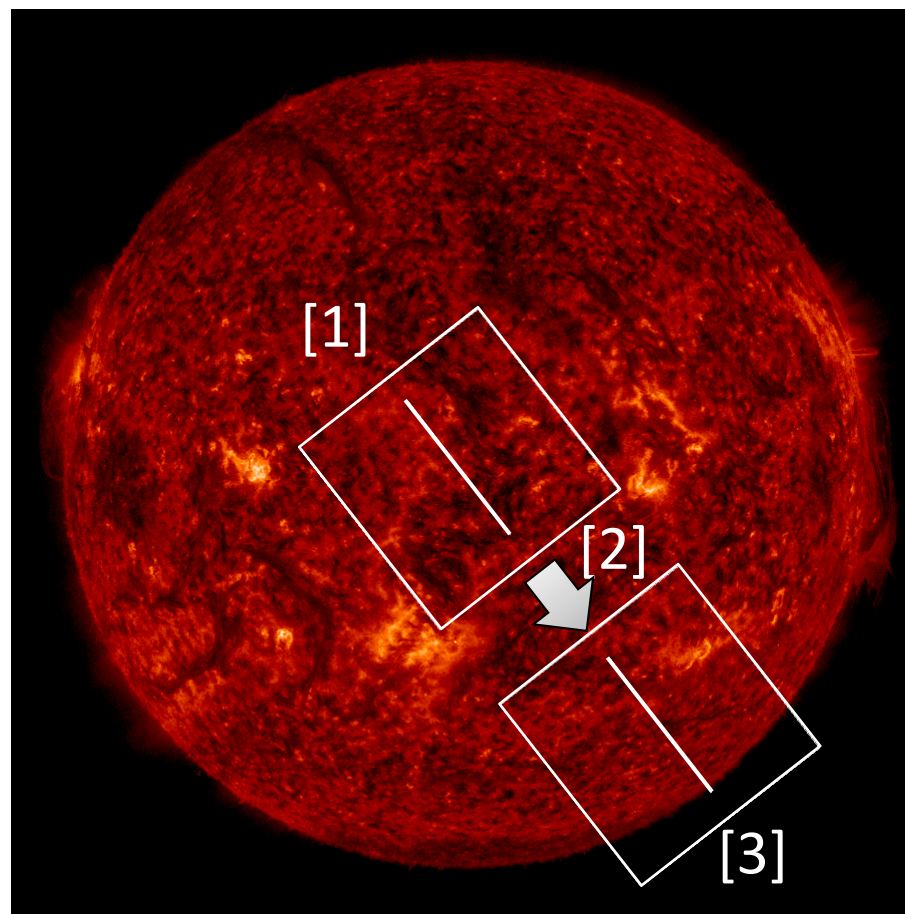
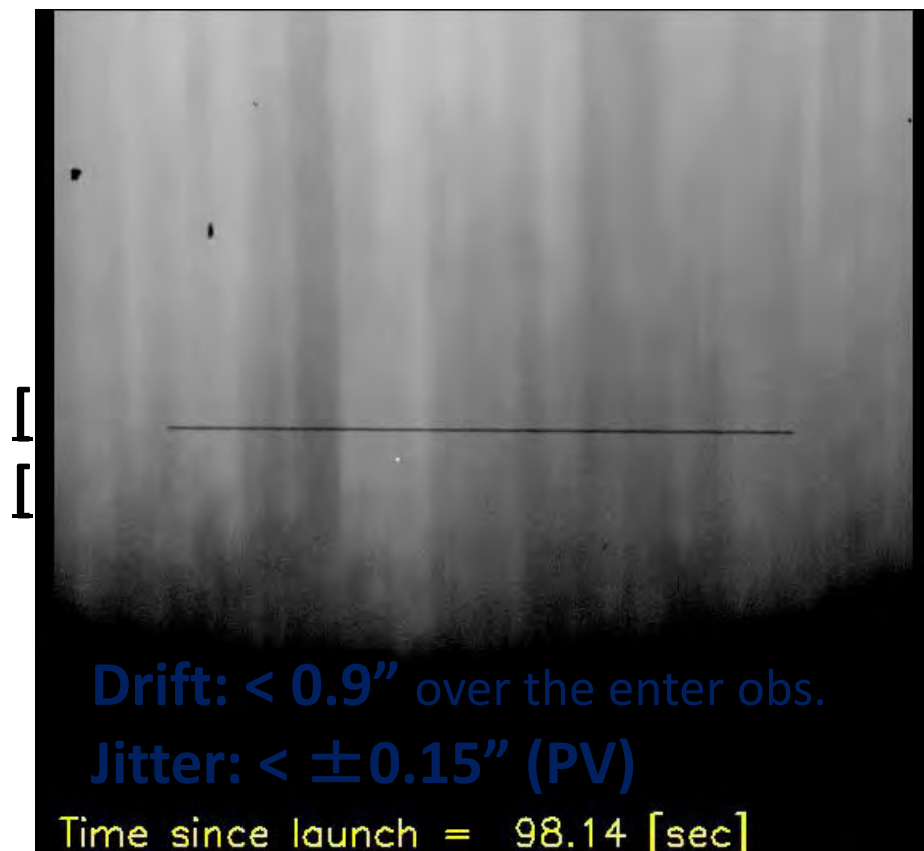




Observing procedure

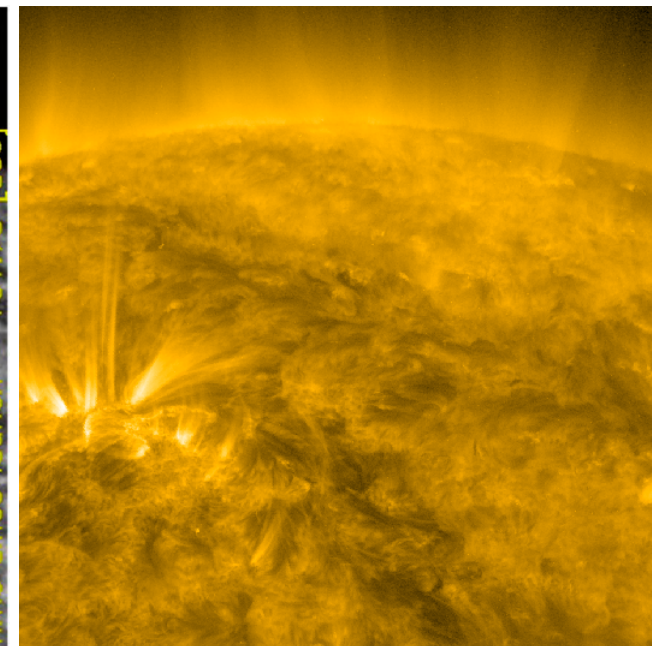
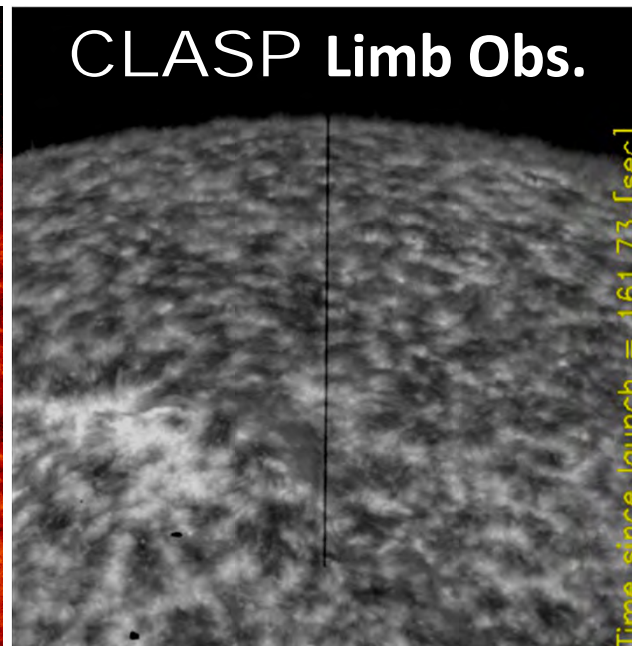
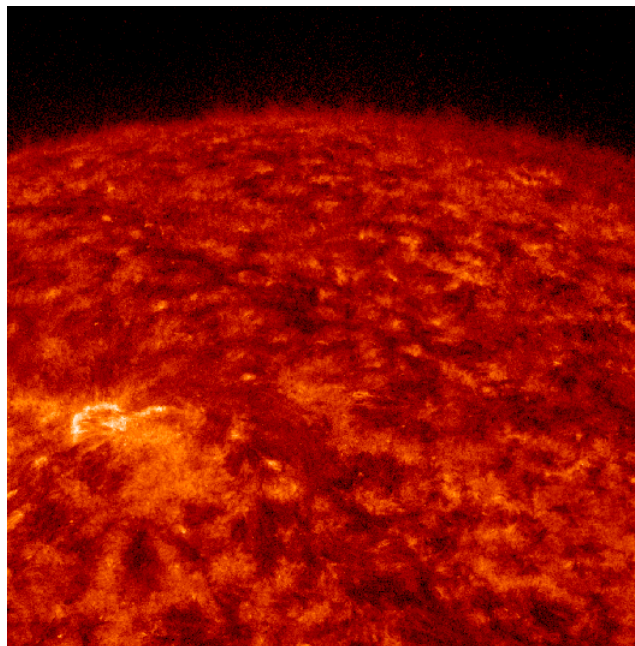
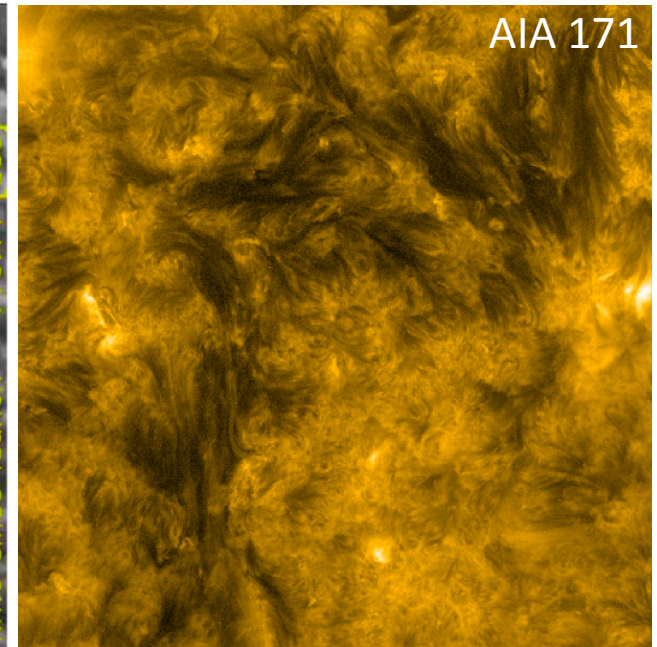
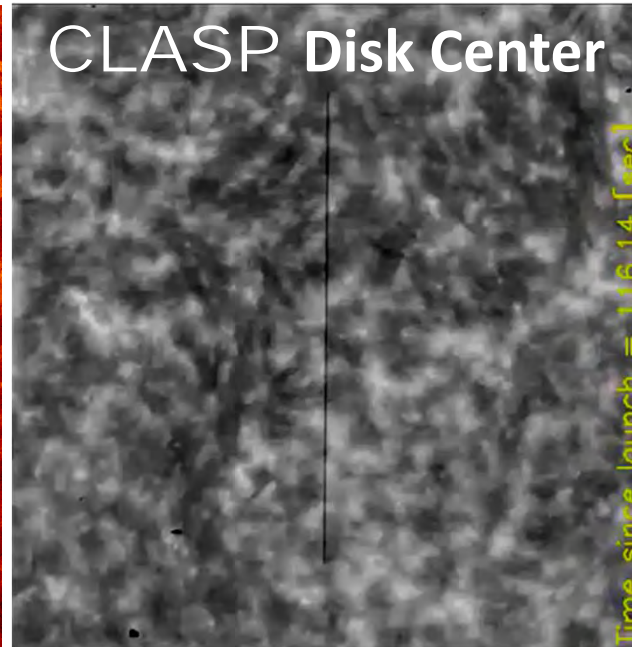
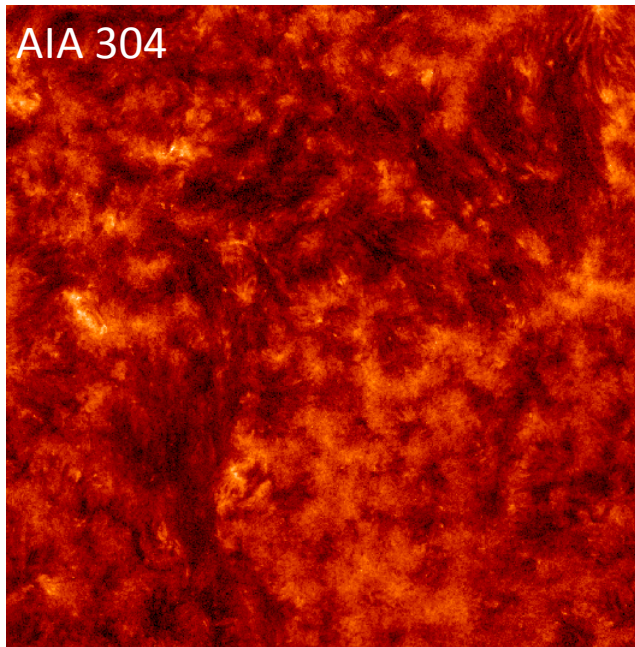
Peak height was ~ 278 km.

I CLASP Slitjaw(SJ) movie



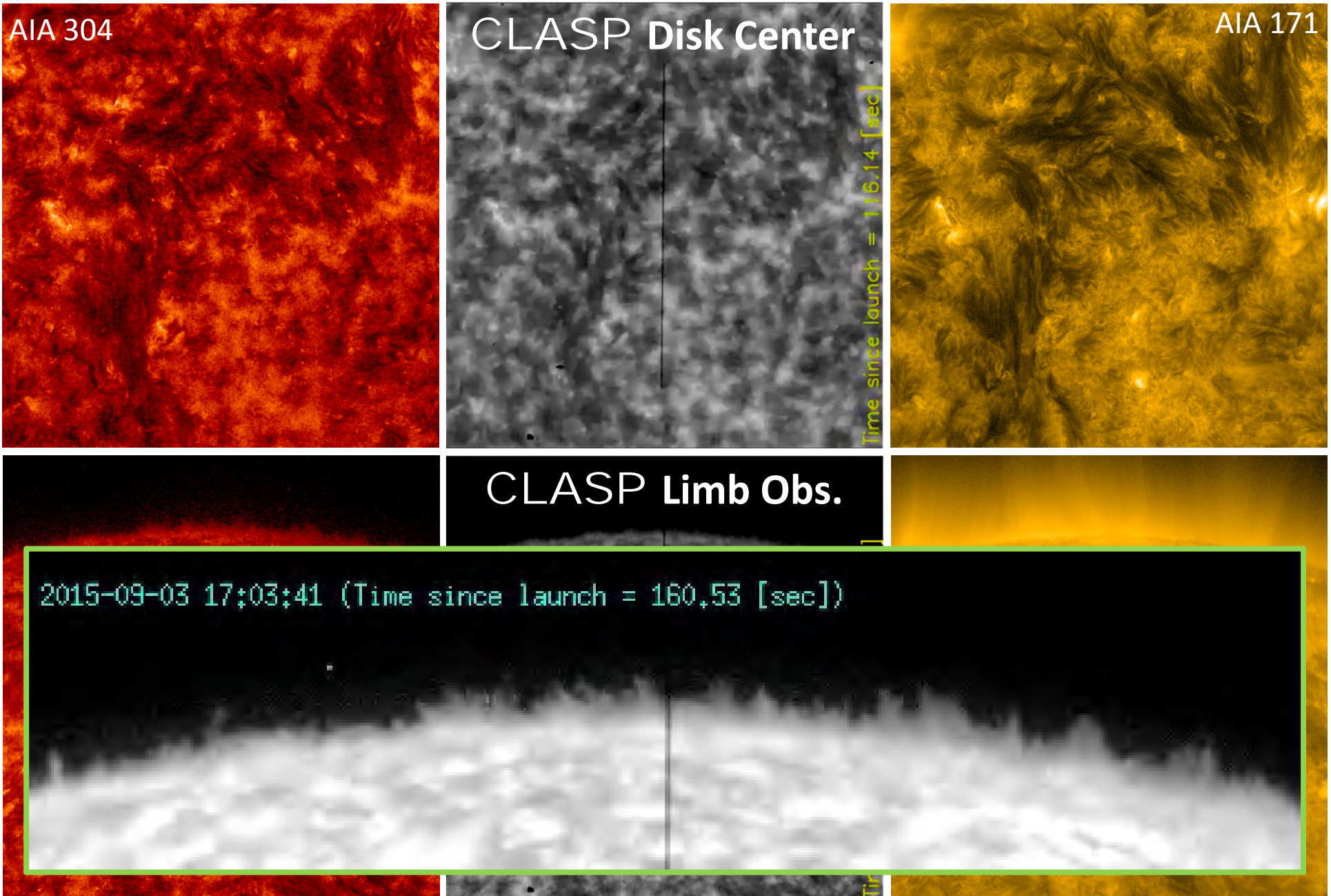


Slitjaw Movies! -- 0.6s cadence





Slitjaw Movies! -- 0.6s cadence





Lyman- α Spectrum taken with Spectro-Polarimeter (SP)

Ch2

CLASP SP images

Ch1

CLASP SJ image

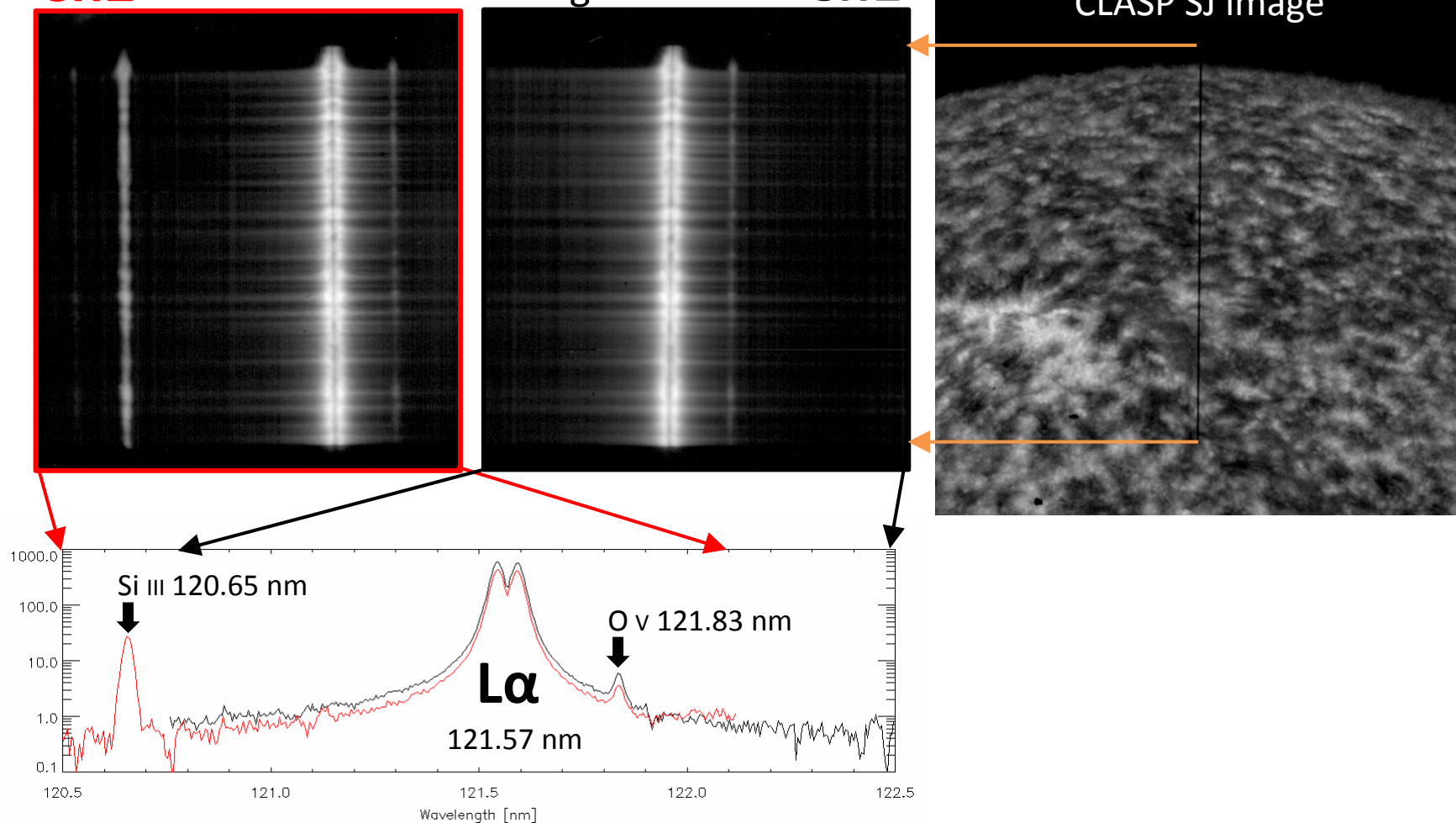




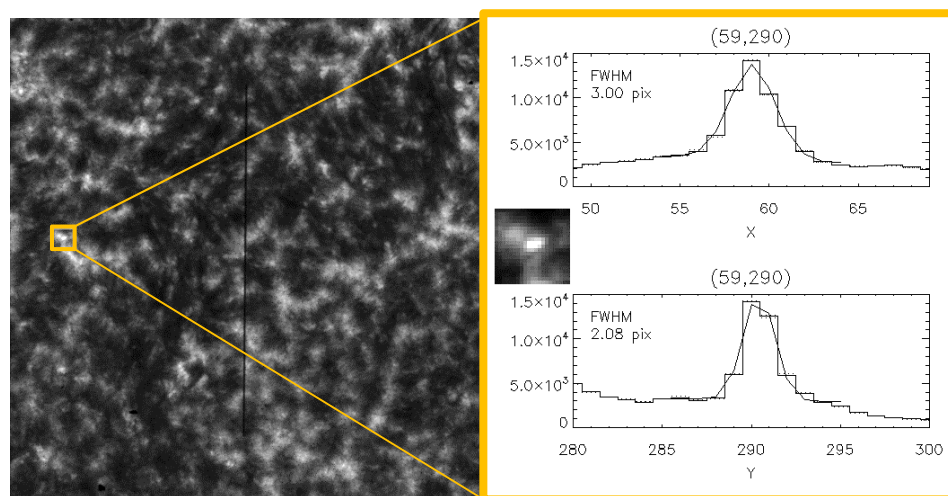
Image Quality

Spatial resolution

- Fitting of a bright point in SJ image.
 – FWHM < 2.1" (2.08 pix)
 (The SJ pixel size is 1.03".)

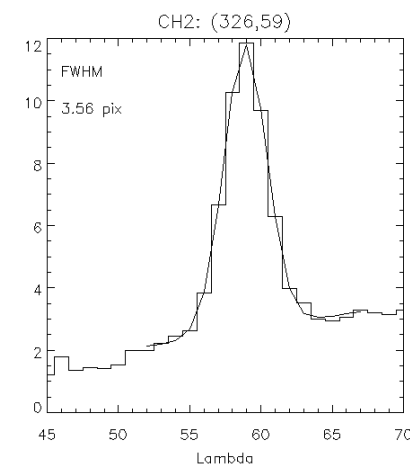
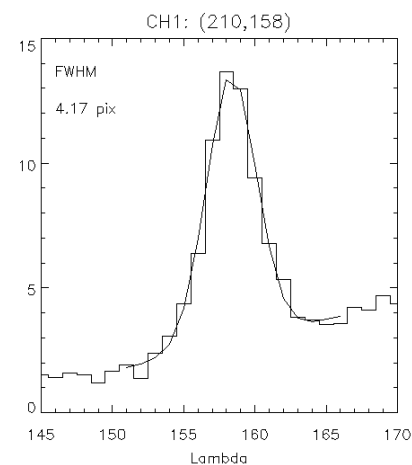
Wavelength resolution

- Fitting of a Ov line.
 – FWHM < 0.017nm (3.56 pix)
 (The SP pixel size is 0.0048nm and 1.11".)



2015/09/17

Hinode 9



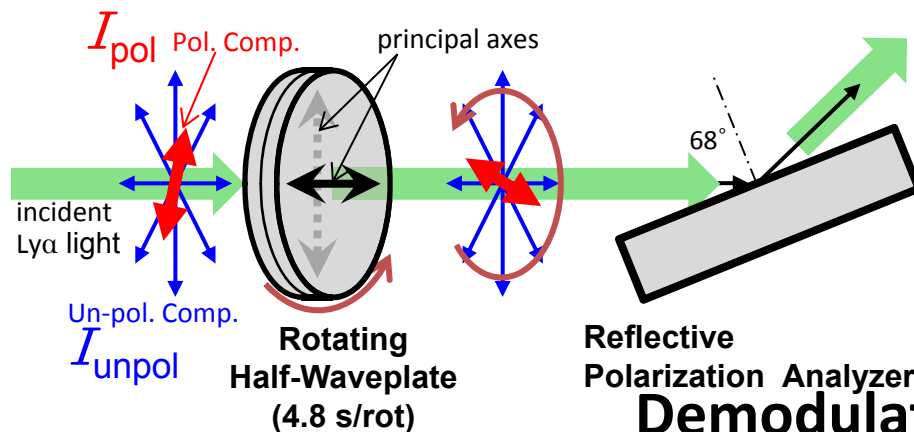
10



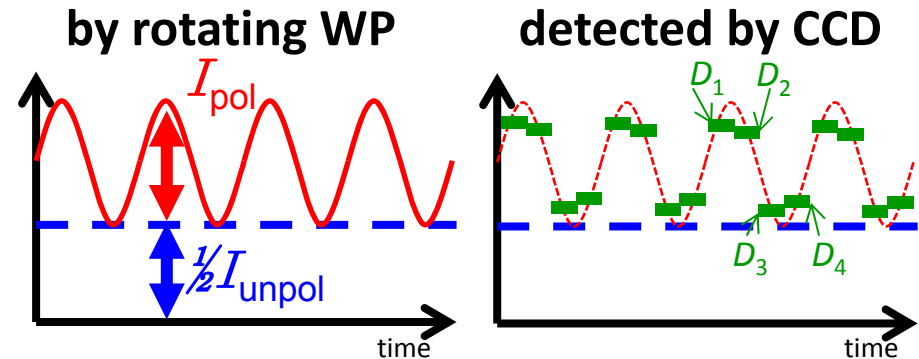
Modulation & Demodulation

- CLASP is optimized for linear polarization, because V/I is expected to be too small ($\sim 0.005\%$ @10G in the Ly-alpha by Zeeman effect).

CLASP Polarimeter



Modulation



Demodulation

from CCD exposures

$$Q = aK\{(D_1 - D_2 - D_3 + D_4) + \dots\}$$

$$U = aK\{(D_2 - D_3 - D_4 + D_5) + \dots\}$$

$$I = K\{(D_1 + D_2 + D_3 + D_4) + \dots\}$$

a : modulation coefficient

K : throughput value

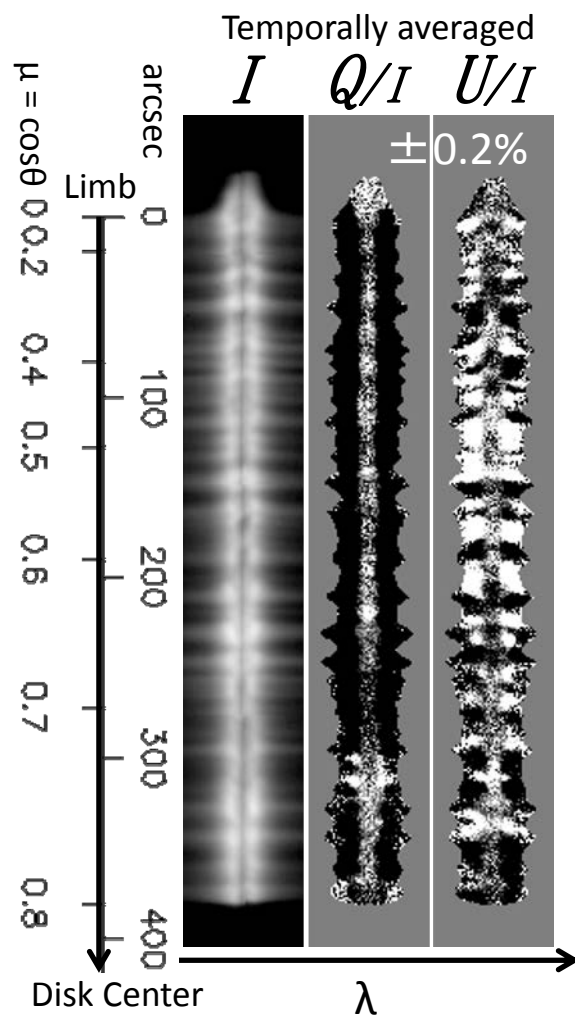


- **A few %** of polarization in the wing, and **a few of 0.1 %** in the core.
- A clear **C-to-L variation** in the wing of Q/I.
- Small-scale structures along the slit.
- Q/I profile is essentially **consistent with the model prediction**.



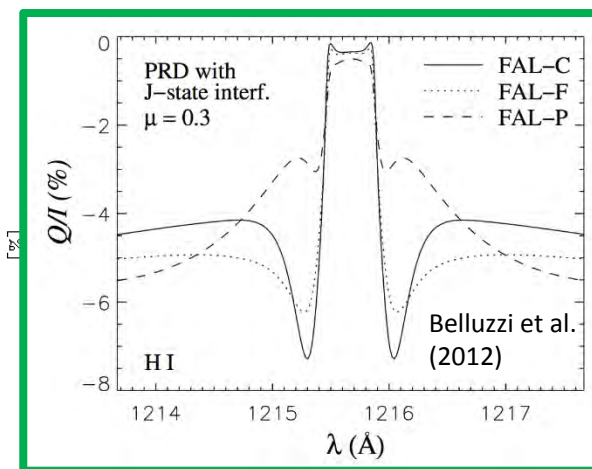
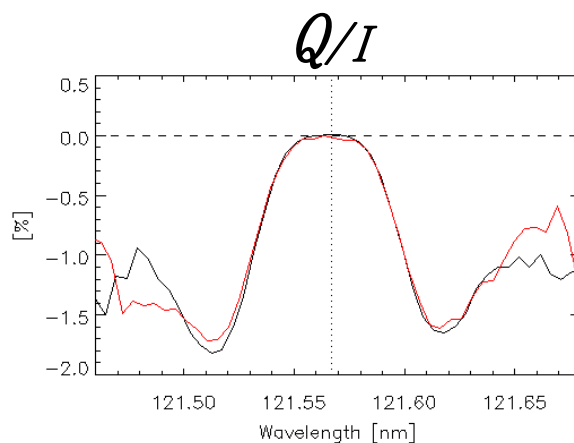


Lyman- α Stokes-IQU



Further calibrations/investigations are required, but ...

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Spatially and temporally averaged



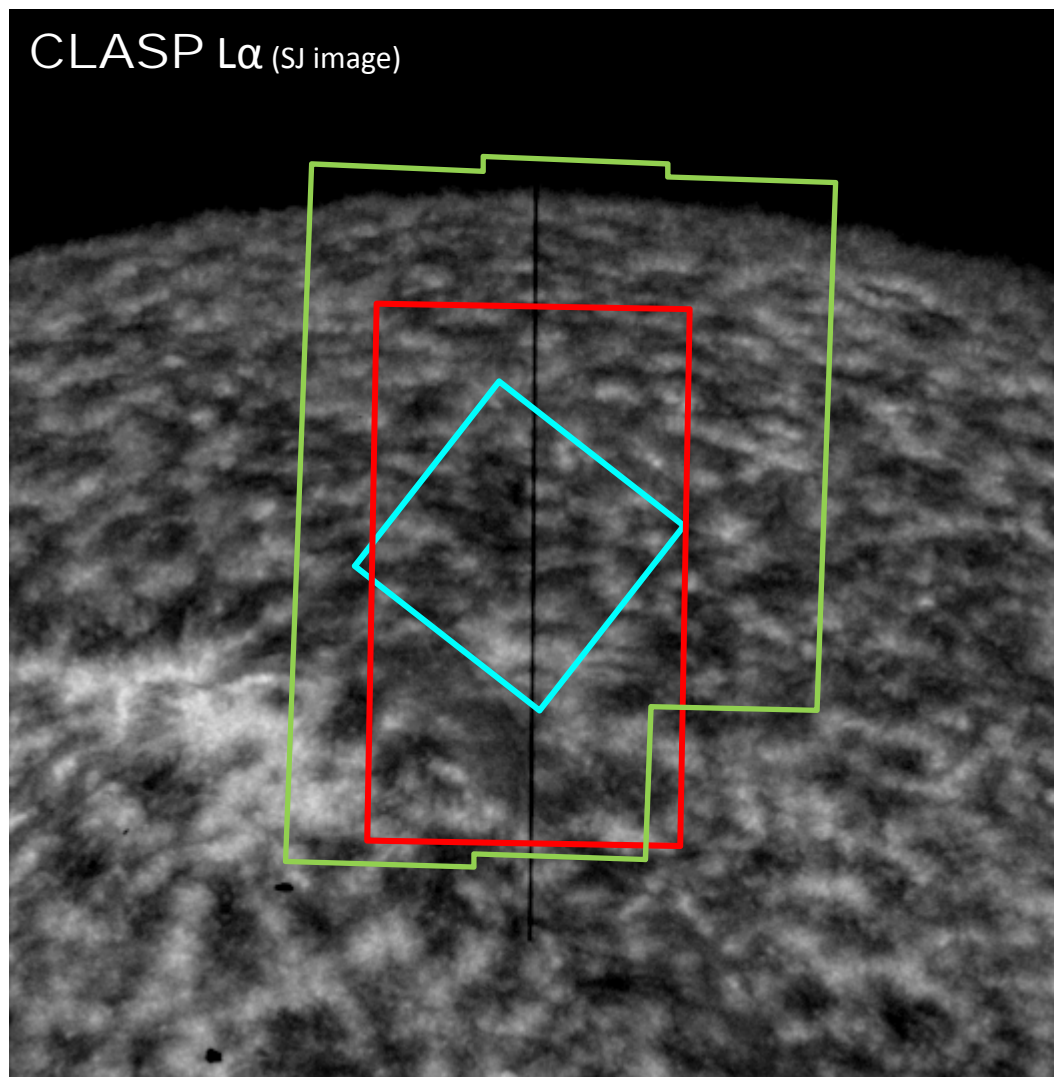
Coordinated Observations

- Hinode
 - SOT SP: Fe I 630nm, 5''(scan)x164''
BFI: Ca II H 397nm, 111''x111''
NBI: Na I D 589.6nm, 82''x164''
 - XRT Al-poly., 768''x768'', 30s-cad.
 - EIS 60''(scan)x512''
- IRIS Mg II h&k, 30''(scan)x275''
- DST (partially clouded)
 - IBIS H α 656.3nm, 98''x98''-mosaic
 - ~~– FIRS He I 1083nm, 60''(scan)x80''~~





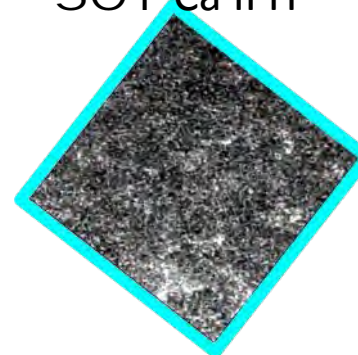
Coordinated Observations



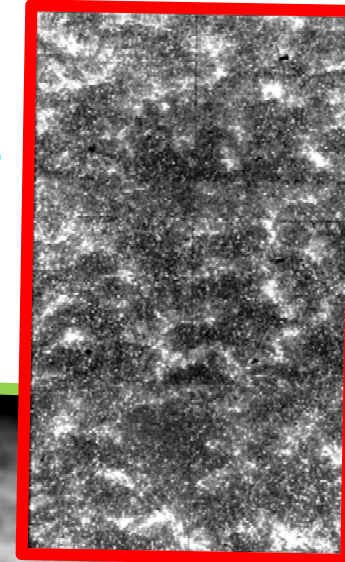
2015/09/17

Hinode 9

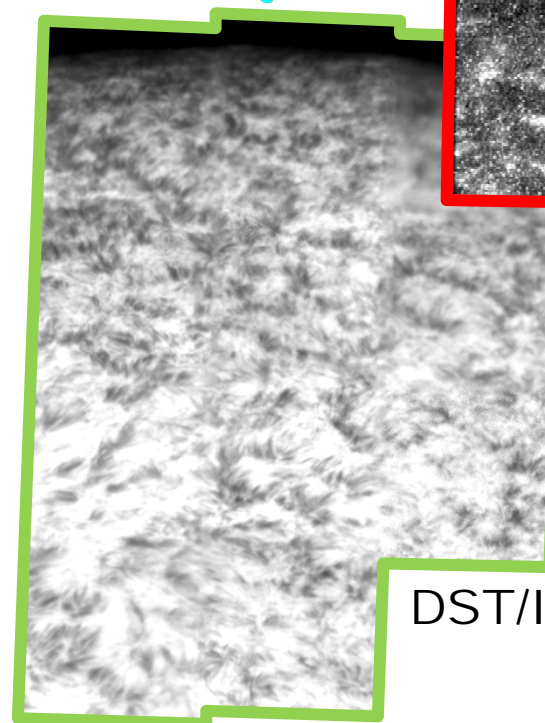
SOT Ca II H



IRIS Mg II (SJ image)



DST/IBIS H α



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Analyses just started.

- Ly α polarization by SP
 - On-flight calibration of polarization by DC data.
 - Detailed investigation of the Stokes-Q and U spectra.
 - Infer the magnetic fields in the chromosphere and TR.
- Ly α spectra by SP with 0.3s cadence.
- Ly α Slitjaw images with 0.6s cadence.
 - High cadence observation will reveal tiny events in the chromosphere (e.g. nano-flares, waves ...).

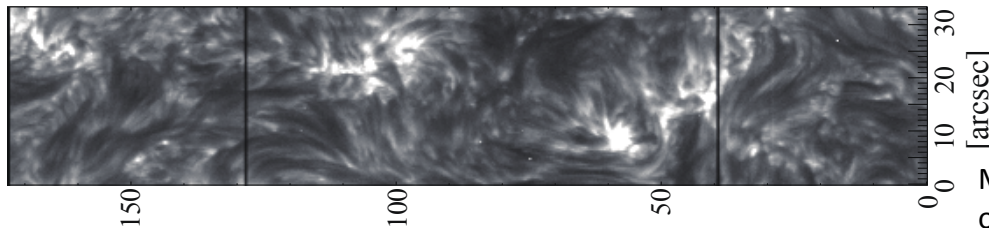
... and others.

Visit e-Poster for the pre-flight calibration by G. Giono.



What's next? CLASP2

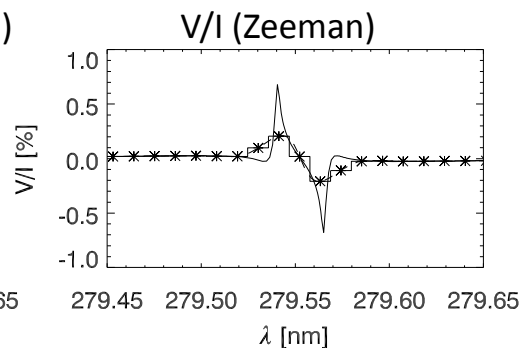
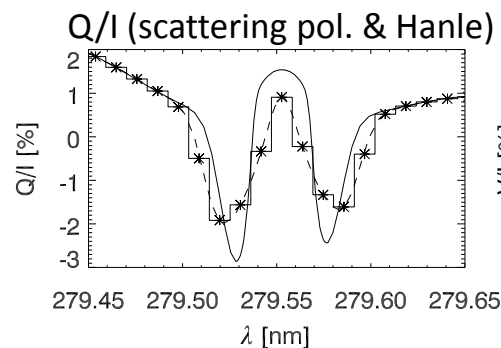
- The same optical design and structure, but for **Mg II h & k**.



Observing target: QS and plage (if available)

Mg II h& k line core image obtained by IRIS

- And take **Full Stokes**.

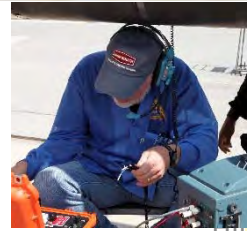
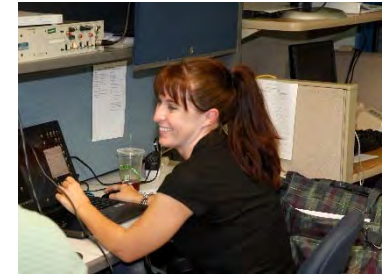


Measurement of **circular** as well as linear polarizations

Belluzzi & Trujillo Bueno (2012; ApJ letters).

- Proposed to fly in 2018 Spring!







Summary

- CLASP was **successfully** launched on Sep.3, 2015, and made a **perfect** Lyman- α spectro-polarimetric observation.
- **A few %** of polarization were observed in the Lyman- α wing, and **a few of 0.1 %** in the core. But, further investigations are required.
- The coordinated observations (IRIS, Hinode etc.) were also succeeded.
- CLASP2 for **MgII h&k** has already been proposed to NASA for the flight in 2018.